International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN (P): 2249-6890; ISSN (E): 2249-8001
Vol. 8, Issue 3, Jun 2018, 911-914

EFFECT OF CUTTING SPEED ON GENERATION OF HEAT AT WORK-TOOL INTERFACE OF COPPER BASED SILVER AND BRASS ALLOYS

MRUDULA PRASHANTH[1], B. S. AJAY KUMAR[2] & N. J. KRISHNA PRASAD[3]

[1]*Department of Mechanical Engineering, Amrita School of Engineering, Bengaluru, Amrita Vishwa Vidyapeetham, India*

[2]*Department of Mechanical Engineering, Bangalore Institute of Technology, Karnataka, India*

[3]*Department of Industrial Engineering and Management, Bangalore Institute of Technology, Karnataka, India*

ABSTRACT

Copper and its alloys are extensively used in various electrical and other industrial applications, due to its high thermal and electrical conductivity. The machinability of copper depends on its alloying elements and its composition. The addition of alloying elements reduces machinability and hence the amounts of heat generated also variable which is dependent on the composition of the alloying element and the machining parameters. The current research is an attempt to study the amount of heat generated at the work tool interface for varying cutting speeds and varying compositions of brass and silver in copper. The research reveals that the number of heat generated decreases as the amount of silver content increases in the alloy indicating higher thermal conductivity.

KEYWORDS: Copper, Brass, Silver, Heat Generation & Cutting Speed

Received: Apr 20, 2017; **Accepted**: May 16, 2018; **Published**: Jun 09, 2018; **Paper Id**: IJMPERDJUN201896

Original Article

INTRODUCTION

Copper and Copper alloys are divided with respect to machinability into three groups, namely highly machinable, moderately machinable and difficult to machine [1]. The machinability of Copper is improved by adding brass. Brass in Copper alloys with concentration about 2% by weight improves machinability i.e., plastic deformation [2] by acting as a chip breaker and increases the brittleness of the alloy [3], but reduces the conductivity of copper. As Pure Silver (also called fine silver) exhibits the highest electrical and thermal conductivity of all metals, pure silver in small percentages can be added to retain the conductivity of copper.

Thermal conductivity is an important factor in the cutting process. The importance of the knowledge of temperature measurement at the cutting point of the tool-work interface arises due to the changes in the cutting condition, and it is well known due to severe effects on the tool and work piece material [4, 5]. During machining, heat is generated at the cutting point from three sources, i.e. primary, secondary and tertiary sources [6]. The flow of the chip against friction on the tool rake face is another source of heat. Similarly rubbing on the machine surface of the flank face (due to elastic recovery and wear of flank face) is a tertiary source of heat generation. All these four sources of heat tend to raise the temperature of chip, tool and work piece; which in turn affects machinability [7]. Almost, 80% of the heat is consumed in the primary and secondary zones of deformation [8]. It is clear that heat is developed within the chip material and the amount of heat from the chip gets conducted into the work piece and into the tool through the chip tool interface. The distribution of heat generated between tool

chip and work piece may vary according to the condition of the process [9, 10].

The present work is an attempt to quantify the variation in the amount of heat generated at tool work interface for varying compositions of the alloy. Non-contact type temperature measurement device has been utilized to record the temperature, due to its simplicity in recording and in its design. Varying temperatures are recorded at different machining conditions like cutting speed, feed and depth of cut and the amount of heat generated is quantified using the measured temperatures.

EXPERIMENTATION AND TESTING

The different alloy compositions are cast using stir casting method [11], as it is considered as one of the easiest methods which can generate good castings. The process of casting, pilots with ETP copper being used as the base material and is melted. When it reaches molten state, alloying material, i.e. Brass and Silver are fed. Upon continuous stirring, the solid solution of copper, brass and silver is formed which is poured into the dies of required dimension and allowed to solidify. The rods are machined to the required size of the specimen and the dimensions are as shown in the following figure 1.

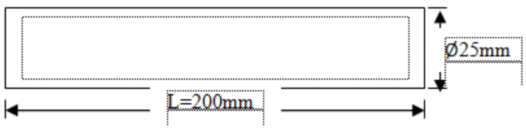

Figure 1: Size of the Specimen

The specimen is mounted in between centers on Lathe machine tool and it is machined at varying speeds, at constant feed and depth of cut. The tool utilized is High Speed Steel (HSS), which is generally utilized in most of the machining processes due to its good properties and ease of availability. The procedure is repeated on varying compositions of alloys, such as copper with 2% silver and 3%, 6% and 9% brass; copper with 4% silver and 3%, 6% and 9% brass. A total of 6 compositions was cast. The varying speeds (in RPM) that are considered for the study are 250, 420, 710 and 1200. All the specimen of varying composition is run at these speeds, maintaining feed of 0.08mm/rev and depth of cut to be 0.5mm constant. A minimum of 5 samples is tested at each speed and each composition and an average reading is drawn for recording

When these specimens are machined at the above said conditions, a non-contact type temperature measuring device is used to measure tool- tip temperature for different machining conditions. The variation in the temperature is recorded. Further the differences in the temperature between different speeds of the samples are noted and plotted across for observation and interpretation and is as presented in the following figure 2 and figure 3 respectively.

RESULTS AND DISCUSSIONS

The following figure 2., reveal the comparison of the variation in the increase of temperature at the tool-work interface which is machined with varying speeds of 250, 420, 710 and1200 rpm for various compositions of 3%, 6%, 9% brass respectively in copper alloy containing 2% silver in it. The comparative analysis reveals that, by adding 3% or 6% brass to the copper, silver alloy, the heat generated at the tool-work interface would increase with an increase in the cutting speed and drastically increases at a cutting speed of 1200rpm. Whereas, at 6% addition of brass, the heat generated at the interface, increases exponentially with cutting speed but suddenly falls at a speed of 1200rpm. An addition of 9% brass

also leads to an increase in amount of temperature rise for incrementally varying cutting speeds and is as shown in figure2.

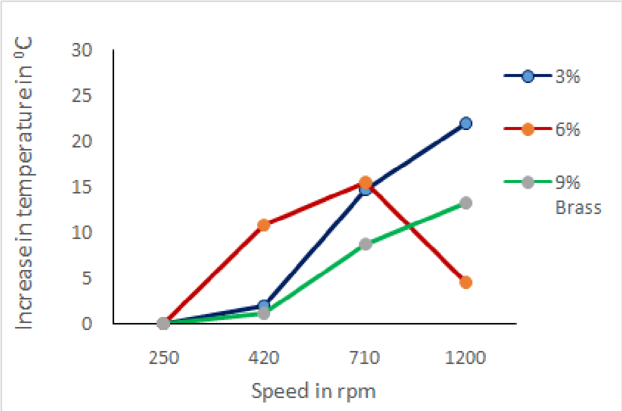

Figure 2: Graph Representation the Increase in Temperature with Increasing Speed at Varying Compositions of Brass (3%, 6% and 9% Respectively) in 2% Silver and Copper Based Alloy

The figure 3., depicts the comparison of the variation in the increase of temperature at the tool-work interface at varying cutting speeds for various compositions of 3%, 6%, 9% brass respectively in copper alloy containing 4% silver in it. The study reveals that, the addition of 3%brass and 6% brass increases the amount of heat conducted which is run up to a speed of 420rpm, but both of them have more or less the same amount of heat generated. At a speed of 420 rpm and above, the amount of heat generated increases with increase in cutting speed up to 1200rpm. Further, 6% brass takes a lead with increase in cutting speed. An insignificant variation is seen with the addition of 9% brass into the alloy composition wherein the increase in temperature is found to be a bare minimum at all the varying cutting speeds.

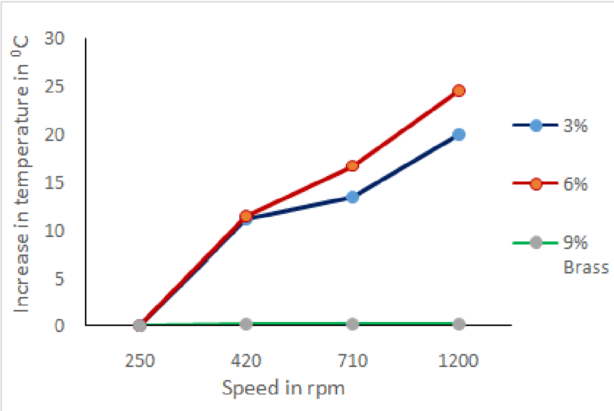

Figure 3: Graph Representation the Increase in Temperature with Increasing Speed at Varying Compositions of Brass (3%, 6% and 9% Respectively) in 4% Silver and Copper Based Alloy

This clearly indicates that more amount of the heat is conducted by the material and the friction reduces to a great extent.

When a similar comparison is made with respect to 2% and 4% silver compositions, the results indicate that, the increase in silver content by 2% reduces the amount of heat generated which is around 8-13% approximately for a cutting speed of 710 and 1200 rpm, whereas at 420rpm the heat generation rather increases except for a composition containing brass of 9%. This indicates that the material becomes more conductive in its nature during the process of machining.

Hence we can infer that thermal conductivity increases. Also, from literature, it is understood that, the increase in hardness due to the addition of brass results in increase of hardness [12] and makes it difficult to cut and hence increases the work-tool interface temperature. This behavior of the material can be further studied microscopically to analyze the structural variation and its cause that led to the above said result.

CONCLUSIONS

The heat generated at the work surface having an increase in addition of silver to the copper, brass alloy decreases, this indicates that the material becomes more thermally conductive upon addition of silver. Further, the addition of brass increases the amount of heat generated by an increase in the cutting speed, except for an addition of 9% of brass. The enhancement of hardness which is a result of addition of brass to the alloy which makes it difficult to cut and hence the increase in temperature at the work-tool interface occurs.

REFERENCES

1. *Cost-effective manufacturing – machining brass, copper and its alloys, Publication TN44. UK: Copper Development Association; 1992.*
2. *Prakash Marimuthu K, Thirtha Prasada H P, Chethan Kumar C S, Force, Stress prediction in drilling of AISI 1045 steel using Finite Element Modelling, IOP Conf. Series: Materials Science and Engineering 225 (2017) 012030 doi:10.1088/1757-899X/225/1/012030*
3. *ASM Hand book in copper and copper alloys. Metals Park: American Society for Metals; 1979.*
4. *X. L. Liu, D. H. Wen, Z. J. Li, L. Xiao, F. G. Yan, 2002,"Cutting temperature and tool wear of hard turning hardened bearing steel", Journal of Materials Processing Technology 129, pp 200-206.*
5. *W. Grzesik, P. Nieslony, 2000, "Thermal Characterization of the Chip-Tool Interface when using coated turning Inserts", Journal of Manufacturing Processes Vol. 2/No. 2*
6. *Pradip Mujumdar, R. Jayaramachandran, S. Ganesan, 2005, "Finite element analysis of temperature rise in metal cutting processes", Applied Thermal Engineering 25, pp. 2152-2168*
7. *Boothroidh, G.; Temperature in Orthogonal Metal Machining, Proc. Instn. Mech. Engrs (London), vol 77, p. 789 (1963).*
8. *Chao, ET. And K. J. Trigger.; Temperature Distribution at the Tool-chip Interface in Metal Cutting; Trans. ASME, vol. 77, pp. 1107-1121 (1955).*
9. *Arndt, G. and R. H. Brown, On the Temperature Distribution in Orthogonal Machining, "Int. J. Mach. Tool Des. Res., vol. 7, p. 39(1967).*
10. *Scrutton, R. F.; Thermal Analysis of Metal Flow at the Chip-Tool interface; Trans. ASME Ser. B, J. Engg. for Ind., vol. 89, pp. 539-542(1967).*
11. *B. P. Harichandra, M. Prashanth, M. Mahapati, S. V. Prakash, Evaluation of Mechanical Properties of EN31 steel heat treated using Biodegradable oils, International Journal of Applied Engineering Research, 2015;10 No.50:1248-1252.*
12. *Mrudula Prashanth, N Satish, B S Ajay kumar, Effect of Brass and Silver on Mechanical Properties of Copper, Materials Today; Proceedings, Elsevier Publications, InPress.*